Living shorelines in the Chesapeake: A habitat- and water quality-enhancing solution to shoreline erosion

Chesapeake Bay Trust
"Living shorelines" are defined as shoreline stabilization techniques that use as many natural habitat elements as possible to protect shorelines from erosion while also providing critical habitat for Bay wildlife.
The “Problem:” Eroding Shorelines

33% of all Chesapeake Bay shorelines are actively eroding.
The “Problem:” Eroding Shorelines

Erosion is a natural process

7,000 years ago  present  10,000 years from now

Maps courtesy of UDel
The “Problem:” Eroding Shorelines

Erosion is a natural process.

Human processes play a role.

Sea Level Rise: > 1 foot (40 cm) last century
Hardening of Shorelines

We’re hardening our shorelines to protect against erosion

28-32% Maryland is armored
11-19% Virginia is armored
But armor doesn’t always work, and people starting thinking it might not be so good for critters.
History of “Living Shorelines”

● 1970s Environmental Concern begins experimenting with purely non-structural approaches. Failures abound
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1972 – Ed Garbisch, Environmental Concern

Control of upland bank erosion through tidal marsh construction on restored shores: Application in the Maryland portion of Chesapeake Bay

Hambleton Island restoration: Environmental Concern's first wetland creation project.
History of “Living Shorelines”

- **1970s**: Environmental Concern begins experimenting
- **1980s**: “Living shorelines” term coined in MD; hybrid concept developed
Non-structural living shorelines: natural habitat elements only: vegetation, oyster reef, coarse woody debris, sand.

Hybrid living shorelines: include natural habitat elements, as well as some hard structures such as stone sills or breakwaters.

Structural practices without a natural habitat component:
- Bulkheads/Seawalls
- Revetments
- Breakwaters
- Groins/jetties

Types of Living Shoreline Projects/Designs

- Non-structural living shoreline
- Low-structure hybrid living shoreline
- Medium-structure hybrid living shoreline
- Structural erosion control practice
Non-Structural

BEFORE

AFTER

Hidden Pond,
Crownsville, MD
Low Structural

BEFORE

St. Johns College, Annapolis, MD

AFTER
Hybrid Living Shorelines

Segmented Sill Design

Continuous Sill With Windows

window/tidal gate
Hybrid Living Shorelines

BEFORE

Chesapeake Maritime Museum, Miles River

AFTER
High Energy/High Structure

Chesapeake Bay Ecology Center, Grasonville, MD

Asbury Retirement Home, Calvert County

Breakwaters
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● 2008     Research begins: CBT, NOAA - ecological impacts of LS
● 2009     CICEET funds NC work on engineered shorelines
● 2010     NOAA funds Smithsonian work on shoreline value
● 2010     VIMS evaluates engineering
Folks start asking: Are we sure these things “work?”
Ecological: Armor vs. Natural Marsh
Most species more abundant in marsh than armor

Mummichog (*F. heteroclitus*)

Grass shrimp (*P. pugio*)

Density (#/m²)

Marsh control  Bulkhead

West River  College Creek  Miles River  Beards Creek

Chain pickerel

Stickleback

Spot
Ecological: Armor vs. Natural Marsh
Bulkhead lower values of diversity, density
(Bilkovic and Roggero 2008)
Ecological: Armor vs. Natural Marsh
Seawalls - lower values of spp richness
(Brauns et al. 2005; German lakes)

Fig. 2. Median species richness (+ max) of natural and developed shorelines (beach, retaining wall, riprap) within the (a) eulittoral and (b) infralittoral zones. Significant differences (Mann–Whitney U-test) between natural and each type of developed shorelines are indicated by asterisks (**P < 0.01, *P < 0.05).
Ecological: Change in Spp. Diversity and Density hypothesized to be higher at LS sites than control sites

After-Before (change in density; #/sq m)

bulkheads to living shorelines

erosing fringe marsh to living shoreline
Ecological: Armor vs. Living Shoreline – Before and After

Several species increased at sites installed with living shorelines; none decreased

Species density
Physical/Erosion: Sill/Living shoreline sites have higher accretion than natural sites (Currin et al., 2010; NC)

<table>
<thead>
<tr>
<th>Marsh type</th>
<th>Marsh edge location</th>
<th>Net sediment accretion (mm y(^{-1}))</th>
<th>n</th>
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<tbody>
<tr>
<td>Natural</td>
<td>Lower</td>
<td>-6.92 A</td>
<td>4</td>
</tr>
<tr>
<td>Sill</td>
<td>Lower</td>
<td>5.36 B</td>
<td>4</td>
</tr>
<tr>
<td>Natural</td>
<td>Upper</td>
<td>1.18 A</td>
<td>4</td>
</tr>
<tr>
<td>Sill</td>
<td>Upper</td>
<td>4.73 B</td>
<td>4</td>
</tr>
</tbody>
</table>
Using “natural habitats” in armor in other systems (rocky intertidal): It’s not all about wetlands (Bulleri and Chapman, 2010; Italy)

Fig. 2. The number of species of macro-algae and sessile animals living on the façade of the seawall (black bars) and the number of additional species found in the ‘rock-pools’ (clear bars) at three different shore levels (high, mid and low); data summed across all sites (see Designing “rock pools’ into seawalls
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- **2010** VIMS evaluates engineering
- **2010** President Obama’s Ches. Bay Exec Order includes LS goal
- **2010** Rhode Island and NJ begin discussing living shorelines
- **2013** Second Chesapeake Living Shoreline Summit
- **2013-4** Bay Program Expert Panel to grant NPS credit for LS projects
“Living Shorelines” – the solution for all ills

Connection to other issues: Climate Change and Bay Pollution

- 2008  MD Climate Action Plan - LS as climate change defense
Sources of Sediment “Pollution?” in the Chesapeake

- Watershed – Ag and SW
- Oceanic Input
- Shoreline
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We don’t know the percentage of erosion from boat wakes
Is sediment all bad?

Types of sediment loads

- Fines
- Coarse
- Organic

Sediment type

MT/year load

MD
VA

Is sediment all bad?
Baltimore County Essex Skypark Example

2,610 linear feet

Before: erosion rate 1-1.5 ft/yr
bank height 4-7 ft

After: 1.8 acres vegetation

Total pollutant load:
- 462,596 lb TSS/yr
Engaging Landowners

- Demonstration Projects – Demonstrate Success

- Show Access/Consistent Uses
Funding

Living Shorelines – Cheaper than armor in low energy; more expensive at high energy. Who should pay?

- Grant Programs – Full funding or cost-share
- Local jurisdictions - MS4 credit incentives
- Property-owners support it themselves
  - Voluntarily - Property tax incentives
  - Regulatorily – E.g., MD’s law
Top Unknowns

For scientists

1. Efficacy of LS (WQ, habitat, erosion)
2. Monitoring protocol development
3. Efficacy of types of LS and location
4. Adaptation to SL rise
5. Debate about where shorelines should not be protected from erosion

For regulators

1. Tradeoffs (subtidal, riparian buffer)
2. Efficacy of LS (WQ, habitat, erosion)
3. Cost benefit analysis and life cycle costs
4. How do we actually measure success
5. How do we prioritize LS sites basin-wide
1. LS #1 continuous sill with windows
2. LS #2 segmented sill (offshore breakwaters)
3. LS #3 groins
4. revetment
Lessons Learned

- Demonstration sites are key to provide a visual

- Need to demonstrate value during storm events

- Cannot promise a solution for all ills

- There will be those who say too green, and those who say not green enough